



THE  
HORN - BOOK  
OF  
STORMS  
FOR THE  
INDIAN AND CHINA SEAS.

BY  
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"Wherein, if any man, considering the parts thereof, which I have enumerated, do judge that our labour is to collect into an art or science that which hath been pretermitted by others, as matters of common sense and experience, he judgeth well."

BACON,  
*De Aug. Scient.*

Calcutta:  
BISHOP'S COLLEGE PRESS.

1844.

IIA LIB.,

*Publications by the Author on the Law of Storms in the Indian and China Seas.*

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- 1.—*First Memoir.* “Hurricane in the Bay of Bengal, June 1839,” J. A. S. Vol. VIII, pp. 45.
- 2.—*Second Memoir.* “Coringa Hurricane, of November 1839, with other Storms,” J. A. S. Vol. IX, pp. 45.
- 3.—*Third Memoir.* “Cuttack Hurricane, of April and May 1840,” J. A. S. Vol. IV, pp. 46.
- 4.—*Fourth Memoir.* “The Golconda’s Typhoon in the China Seas, September 1840,” J. A. S. Vol. IX, pp. 11.
- 5.—*Fifth Memoir.* “Madras Hurricane of May 1841, and Whirlwind of the *Pa-quebot des Mers du Sud*,” J. A. S. Vol. I, pp. 19.
- 6.—*Sixth Memoir.* “Storms of the China Seas, from 1780 to 1841,” J. A. S. Vol. XI, pp. 100.
- 7.—Two Editions of “Notes on the Law of Storms in the Indian and Chinese Seas, printed by the Government of India for the use of the Expedition to China,” pp. 42.
- 8.—*Seventh Memoir.* “Calcutta Hurricane, 2nd—3rd June 1842.” J. A. S. Vol. XI, pp. 124.
- 9.—*Eighth Memoir.* “Madras and Arabian Sea Hurricanes, 22nd October to 1st November 1842.” J. A. S. Vol. XII, pp. 61.
- 10.—*Ninth Memoir.* “Pooree, Cuttack and Gya Storms of October 1842.” J. A. S. Vol. XII, pp. 42.
- 11.—*Tenth Memoir.* “Madras and Masulipatam Storm, 21st to 23rd May 1843,” J. A. S. Vol. XIII, pp. 45.
- 12.—On an improved Simpiesometer, “The Tropical Tempest Simpiesometer.” J. A. S. Vol. XII, pp. 2.

THE  
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The object of this little work is two-fold ; it is to furnish the mariner with a brief compendium of the beautiful theory to which it relates, with a convenient and illustrative copy of COLONEL REID's Storm Card for use, and at the same time to urge upon the public attention the great need yet existing of farther knowledge of the *tracks* of storms, especially in the southern Indian Ocean and Arabian Sea. The author had frequently furnished friends with copies of Storm cards ; but finding the drawing of them troublesome, was on the point of having some lithographed on paper, when it occurred to him, that if they could be delineated on some transparent substance, their use would, to many, be much more clearly understood than when upon paper or card ; and after many trials, as with plates of mica, &c. it was found that, though somewhat expensive, the lithographed horn-plates which accompany this book were the best. It is right also to mention, that just as he had succeeded, he received from Colonel Reid a copy of his storm cards on paper, engraved in London, shewing that that gentleman also had felt the convenience and utility of having storm cards, to distribute to those who were desirous of profiting by the invaluable discoveries with which he has enriched nautical science.

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The theory commonly called ' THE LAW OF STORMS,' offers a kind of knowledge, which in most cases, will afford the Seaman—FIRST, the best chance of avoiding the most violent and dangerous part of a

hurricane,\* which is always near the centre of it; NEXT, the safest way of managing his vessel, if he is involved in one; and THIRDLY, the means of *profiting* by a storm! by sailing on a circular course round it, instead of upon a strait one through it. The proofs of the LAW OF STORMS, now rest upon the examination of perhaps more than a thousand logs, by Mr. Redfield in America, Col. Reid in England, myself in Calcutta, and many other observers, whose researches have not been published. Up to the present time not only has no contradiction of it been discovered, but every recurring storm in various parts of the world, when closely analysed, gives new proof of its correctness. We may then set it down as what it is called, the *Law* of Storms, or the *rule* by which the motions of rotatory storms are regulated and known.

This term "storm" is not used so much with relation to the *force* of the wind in a storm, as to its *motion*.

A storm or tempest, may mean either a gale or a hurricane; but it always means here a storm of wind; and not, as frequently used by landsmen, one of thunder and lightning only.

A *gale* means a storm of wind, the direction of which is tolerably steady for a long time; sometimes not only for days, but for weeks, as our common monsoon gales.

A *hurricane* means a *turning* storm of wind blowing with great violence, and often shifting more or less suddenly, so as to blow half or entirely round the compass in a few hours.

There are in tropical countries two kinds of tempests or storms. The monsoon or trade wind *gales*, in which the barometer remains high, and the wind steady, and the hurricanes, or tyfoons; often blowing with irresistible fury, and almost invariably accompanied by a falling barometer.

With this explanation of our words, we shall better understand the things treated of.

The present state of our knowledge shows, that, for the West Indies, the Bay of Bengal, China Sea, and the Southern Indian Ocean,

\* All the great tropical and many of the extra-tropical storms are now clearly ascertained to be hurricanes: i. e. great *turning* tempests moving forwards. They vary only in size and in the courses they take, but not in the way in which they turn in the same hemispheres, as will be afterwards shewn.

the wind in a hurricane has two motions, the one a turning or veering round upon a centre, and the other a straight or curved motion forwards ; so that like a great whirlwind it is both turning round, and as it were, *rolling* forward at the same time. It appears also, that it turns, when it occurs on the North side of the Equator, from the east, or the right hand, by the north, towards the west, or *contrary* to the hands of a watch ; and in the Southern hemisphere, that its motion is the other way, or *with* the hands of a watch ; being thus, as expressed by Professor Dove of Berlin, S. E. N. W. for the Northern hemisphere, and N. E. S. W. for the Southern hemisphere, if we begin at the right hand, or east side of the circles.

This rule has been found to hold good for numerous storms in the Bay of Bengal, at different times of the year, which have been carefully investigated ; and that the wind was in them really blowing in great circles, in a direction as described, *i. e. against* that of the hands of a watch. We assume then, for the present, that the hurricanes in the Bay of Bengal always follow this law.\*

The horn plates in the pockets of this book are what is called Col. Reid's Hurricane, or Storm, circles, or cards.

The use of these is to lay down and move upon any part of a chart, they may be supposed to represent a circle of fifty, or of five hundred miles in diameter, as we please ; and one which would fill up the North part of the Bay of Bengal, would shew the wind in the same storm, South on the coast of Arracan ; East on the Sand Heads ; North on the coast of Orissa ; and West across the middle of the Bay ; and if we move it over a chart, the changes of the wind for a ship or an island on its track will be seen.

We have now to judge of three important points : What is the track of the hurricane if it is to be one ? In what direction does it bear from us now ? How far are we from its centre ?

We do not yet know what is the usual track of all the hurricanes or turning storms to the East of the Cape. We know from Col. Reid's and Mr. Redfield's researches, that those of the West Indies begin about the Leeward Islands, travel to the W. N. W., and then round the shores or across the Gulf of Mexico, and, following the Gulf stream, are lost in the Atlantic between the Bermudas and Halifax, and

\* Vide Memoirs published in the Journal of the Asiatic Society, 1839 to 1844.

they have investigated a sufficient number to shew, that this may be taken as a general rule. Those also of the Mauritius seem to come from the Eastward, and to curve round to the South and S. E. again.

For the storms of the Bay of Bengal, I have investigated since 1839, when my first Memoir on the subject was published, a considerable number of them, and many of these investigations have been published. I have many more in notes, and in the results derived from the examinations of numerous documents and log books, old and recent, in which I have as carefully looked for contradictions as for confirmations of these laws of rotation and progression, and I should consider it as now proved, beyond doubt, that as to rotation, all our storms, excepting the monsoon gales, turn as above explained for the Northern hemisphere, and that their tracks are lines more or less straight or curved, and varying in their direction as they approach the coast. From E. b N. to W. b S. and from S. S. E. to the N. N. W. seem at present to be the limits of the tracks, and thus in general terms we may say, that for the Bay of Bengal, the storms always come from the Eastward and travel to the Westward, and perhaps from E. S. E. to W. N. W. will be found an average track. There is no rotatory storm on record which I have yet met with, in which the track comes from the Westward of the meridian. I shall subsequently shew how, by a little care, the seaman can, by the help of the storm card, estimate both the track and the rate of travelling of the storm.

In the China Sea, from the result of the analysis of all the records of storms which I could obtain with the assistance of the Honorable the Court of Directors of the E. I. C., from 1780 to 1841, which will be found detailed at length in my sixth Memoir,\* it appears, that the *mean* tracks of the tyfoons, for the six months, from June to November, in which they occur† are as follows:—

In June, the tracks are from East to West.

In July, the tracks are from between to N. E. and S. E. by E. to the N. Westward.

\* Journal of the Asiatic Society, Vol. XI.

† I have found as yet no record of a typhoon occurring from 1st December to 31st May, in the China seas.

In August, the tracks are from between East and S.  $40^{\circ}$  E. to the Westward and N. Westward.

In September, the tracks are from between N.  $60^{\circ}$  E. to S.  $10^{\circ}$  E. to the S. Westward and N. b. Westward.

In October, the tracks are from between N.  $12^{\circ}$  E. and S.  $45^{\circ}$  E. to the S. b. Westward and N. Westward.

In November, the tracks are from between N. E. and S. E. to the S. Westward and N. Westward, evidently varying with the opposing strengths of the monsoon and trade wind, and probably also influenced by the vicinity of the land.

For the Arabian Sea, we have hitherto tracked but a single storm, but this clearly obeys the law of rotation, and that also, (for it seems nearly a law,) which directs the tracks from the Eastward to the Westward. In this case the track was from about E. S. E. to W. N. W.

In the Southern Indian Ocean, I have already noticed the little we know of the tracks of the hurricanes near the Mauritius, which we owe to Colonel Reid's labours, *i. e.* as coming from the Eastward and curving Southerly, back to S. E. again. There is, however, another part of this great Ocean so subject to hurricanes, that it may perhaps be called a hurricane tract. It lies between  $5^{\circ}$  and  $13^{\circ}$  S. latitude, and  $75^{\circ}$  and  $90^{\circ}$  East longitude. Many vessels have foundered within these limits, and the seaman cannot be too cautious while crossing any part of this tract at any season of the year. The storm card for the Southern hemispheres will shew him on which part of the circle he is, and I have now in hand the investigation of a severe hurricane which occurred there in November and December 1843.

We know, I regret to say, nearly nothing of the Storms of the Timor Sea, for which I have but a few notes. A storm in the northern part of the Mozambique Channel, laid down in Colonel Reid's work, crossed it from East to West, and we know nothing of those severe storms, which occur between the South end of Madagascar and the African coast.\*

The *rate* at which storms travel on these various tracks is also an important element to the seaman. As far as our present knowledge extends, it would appear that the rates at which the storms move onwards on their tracks vary much, being by tolerable accurate data,

\* See what is subsequently said of the recurring of storms in high latitudes.

	Miles per hour.	Miles per hour.
In the Bay of Bengal, from	.. 3	to 39*
In the China Seas, from ..	.. 7	to 24

For other parts, we have as yet no data sufficient to enable us to form a correct judgment.

The reader has now, I hope, a clear idea of what the Law of Storms is, and what is known of the tracks and rates of travelling of rotatory storms in the seas between the Cape and China. I now proceed to shew the uses of the storm cards on horn, which will be found in the pockets of the covers ; one being for the Northern, the other for the Southern hemisphere.

The following rules must be borne in mind :—

1. The card may be supposed to represent any sized storm from 20 to 500 miles in diameter, and as many more circles may be supposed to be added to it as may be necessary to suit the scale of the chart.
2. The *fleur de lis* must always be kept on the *magnetic* meridian when using it.
3. It is always to be placed so, that the wind's place is over the *ship's place*.
4. It is to be moved as required along the known, or estimated, track of the storm.

Let us now *use* the storm cards, by supposing our ship in latitude 14° N. and longitude 89° E., or not far from the middle of the Bay of Bengal, with a strong squally gale at E. N. E., a falling barometer, and other indications of bad weather. We take the Northern card, and placing it so that the ship's place may fall, say on the outer circle just between "wind N. E." and "wind East," we have it of course at the place of the wind, E. N. E., and we see immediately, that the centre of the storm bears S. S. E. from us.

Next, we know that the storms of the Bay of Bengal come generally from about the E. S. E., and travel to the W. N. W., so that we may say with tolerable confidence, "This is a storm coming up from the Andamans and travelling towards Coringa," and if bound down the Bay or to the Straits, we may add, "and if I run on now, I shall run into the heart of it, for I shall in a few hours cross its track, be-

\* This high rate of 39 miles an hour, however, occurs but in one case : from 3 to 15 may be taken as the more usual limit.

fore, upon, or close behind its centre, according to its rate of travelling." As no careful seaman would of course run his ship headlong into a waterspout, neither would he now hesitate, I suppose, to heave to for a few hours, when he will find that the wind has drawn gradually to East, and then to the Southward of East *when his barometer will begin to rise*, and he may safely stand on. It is probable that in doing so he will cross a spot where the hurricane has left its traces in a heavy confused sea. He will see also by moving his storm card to the W. N. W. *how* it is, that (allowing always for his drift or run,) the wind will in a rotatory storm change *as I have here described it*: and indeed what I have described above is, with some little difference of position, the case of a troop ship in April 1840, as shewn in my Third Memoir in the Journal of the Asiatic Society, Vol. IX, but with this difference, that her Captain, unfortunately, being in all probability desirous of profiting by the "fine fair wind,"\* ran down 100 miles towards the track of the hurricane, which travelled up about 180 miles in the same time; and as the ship crossed it close to the centre she was dismasted, narrowly escaped foundering, and was obliged to put back at a ruinous expense to repair damages! It is scarcely possible to adduce a stronger proof of the utility of the Theory. We shall by and by point out what would have been in such a case the safest tack to heave to upon.

Continuing our lesson: let us suppose now, with the card in the same place, that our ship is in the same longitude as before,  $89^{\circ}$ , but in latitude  $11^{\circ}$  or  $11^{\circ} 30'$  N. with the same signs of bad weather, falling barometer, &c. and the wind at W. N. W. Placing the card as before *with the wind's place upon the ship's place*, we see that now, if bound South or to the Straits, we may safely and surely profit by the fair gale; for the farther we get to the South or South East, the more distant we are from the dangerous centre. On the contrary, if bound to the Northward, we should be standing on into danger, if we ventured, especially with a falling barometer to "carry on," since we should then clearly be nearing the centre which now bears N. N. E. from us.

\* It requires, indeed, some little confidence in this kind of knowledge for a Commander to bring himself to what is called "throwing away a fair wind;" and more than one has told me, after being severely damaged that though they suspected from the Law of Storms that they were running into mischief, yet they could not resolve to lose a chance where others might push on and laugh at them.

The seaman may now, and instructively for himself, place the same card in any part of the China sea, so as to have its centre to the Northward of latitude  $11^{\circ}$ , (for I have been able to trace no track of any tyfoon below that latitude,) and then supposing his ship where he pleases, and the storm travelling on some of the tracks before laid down, he will see how it will veer, or not unlikely how it *has* veered with him in some former storm. He may then take the card for the Southern hemisphere, and placing it any where within the hurricane tract, which I have described in the former page, he will there see that all the winds and changes *are exactly reversed*, and consequently, that the management of his ship must likewise be so ; for here a Westerly gale shows him, that he is on the *North* side of the storm, and a Southerly one, that he is on its Western edge, and so on of all the rest. If he supposes his ship to be placed where the wind is N. N. W., and that being bound to the Mauritius, he steers away to the S. Westward with a spanking gale of 9 or 10 knots, but a falling barometer, he will see how quickly he may, if he does not overtake the centre, run headlong into a terrific hurricane at N. E., being close to the centre : and be very lucky if he is only dismasted. This is an instance of a vessel *chasing a hurricane!* and it is of common occurrence.

He has then a clear idea of the first of its uses, that of shewing him how to judge, from the present direction of the wind, how it will change, and from the present position of his ship and the centre of the hurricane, how it will pass or cross him ; or how he will run on his course, or be driven by his drift, out of, or into it. He may in a word look on the centre of the hurricane as a privateer or a pirate, or an enemy of superior force, and make his calculations for avoiding its neighbourhood. He must not forget, that if he has *his* course and drift, the storm has also a course of *its* own, and brings with it currents,\* (often strong ones,) to both of which he must attend. Recollecting this, he may now farther use his storm card, with his log, to judge how the storm itself is travelling in the following manner.

If it be supposed that the hurricane is travelling from the S. E. to the N. W., it will be seen that, supposing the ship in any part of the circle, this will give different changes of the wind to what would occur if it were travelling, say from E. N. E. to the W. S. W. An

\* See subsequent notice of the "Storm Currents."

allowance being made for the ship's track between any two changes of wind, it will be seen that the line between the two points occupied by the centre of the circle, will lie in a direction which is nearly that of the storm.

This may be done by projection as in diagram No. I. To do this, draw a small line through the ship's place at A. in the direction of the wind, which we will call N. E., and another from the same point perpendicular to it, or S. E., which represents the bearing of the centre of the storm from the ship at that time. We can only *guess* at the distance, which we do by estimating it from the violence of the wind, the rapidity of its changes, and the fall of the barometer.\* I should say, that for a strong gale, which would allow a good merchant ship to carry her close reefed topsails and foresail, we might allow 200 miles. For a hard gale, in which the foresail could scarcely be borne, 150 or 100 miles, and for a very severe gale, a still shorter distance. The veering of the wind, the increase of its force, and the fall of the barometer, are of course more rapid the nearer you are to the centre, and some storms are also more violent and travel faster than others.

Let us then put down 150 miles on this S. E. line, or from A. to B., for our present distance from the centre of the tempest, and in six hours afterwards let us suppose the ship to have made 54 miles on a South course, bringing her to C, and that the wind is increasing fast, but is still at N. E., with the barometer falling, and every other appearance of bad weather.†

\* I trust that the day is not distant when we may make the fall of the Barometer in a given time, a *measure* of the distance of the centre of a storm from us, but I have not yet time to follow out my views on this head.

† In the hurricanes of the Bay of Bengal and China Seas it seems not an uncommon circumstance, that in a few hours after their commencement, there is a lull for an hour or two, or more; after which it comes on to blow harder than before from the same quarter. I observe, that this is also noted in the hurricanes off the Isle of France and in the West Indies. This treacherous peculiarity might, without attention to the barometer, deceive those unaccustomed to our tempests. I have not met with an instance of these lulls occurring more than once at the commencement of a storm. I do not allude here to the lull or calm which precedes the shift of wind, which occurs when the centre of a storm is passing over a ship or place, but to a sort of promise of fine weather which occurs at the beginning of it. There is often in all parts of the world an unusual *rise* of the barometer, and also great oscillation of the simple barometer 12 or 24 hours before the commencement of a storm. In tropical seas these phenomena cannot be too much attended to.

Mark off this distance on a South line, and as the wind is still at N. E., draw a S. E. one as before, which points again towards the centre. We have to consider now that we are probably nearer to it than before, for we know that it also, in these six hours, has been travelling to the Westward between 8 and 16 miles at the least. Taking 12 miles an hour, or 72 miles in the compasses, we find that this distance from B will strike upon the S. E. line (which is the perpendicular to the wind's course) at D, which we may thus take to be the new centre. This, it will be seen, gives the storm a W. N. W. course, which is a likely one, and places the ship now at only 58 miles from its centre. It is clear, therefore, that we are thus running in upon it, and though our distances are mere guesses, they are, for the Bay of Bengal and the China Seas, very strong probabilities, because of the continued fall of the barometer, and the great mass of evidence which exists to prove that almost all these storms are turning gales, and move from the Eastward to the Westward.

I have placed on the Southern half of the Diagram a case wherein another ship, in the same tempest, at the same time, but at a distance of 220 miles from the first one, may have the wind at N. W. first, and steering N. E. 54 miles, bring the wind to West, because the centre of the hurricane, travelling as we suppose, bears then about 82 miles North from her. From evidence published in my Fourth Memoir, Jour. As. Soc. Vol. X, there seems little doubt that the unfortunate ship *Golconda*, which foundered with 300 Madras troops on board, must have run from the South side of a hurricane into its centre, in the hurricanes of 22nd to 24th September 1840 in the China Seas, as I have supposed this vessel to be doing.

The Storm cards may also be of great use on our inland river navigation, for supposing a storm coming on, and its veering to indicate a track which will bring the wind nearly to an opposite quarter at the latter part of the gale, it is clear that a boat, safely placed under shelter of a weather shore at the first part, may find herself anchored on a dangerous lee-shore in the latter part of a tempest; whereas by choosing a proper spot, or shifting her birth in the lull which so often precedes the change, a valuable cargo, and often human lives, might be saved.

Having shewn how the careful seaman may in most cases, if he has sea-room, avoid running into, or being overtaken, by a rotatory storm,

I now proceed to shew, and this will surprise many who have not yet paid attention to the subject, how these, often terrific, tempests may sometimes be turned to great advantage ; to *such* advantage at least, as to compensate on one voyage, by the gain of some days in a passage, for what owners might, till they also understand the advantages of it, consider the *loss* by heaving to, to allow a storm to pass, on another.

Suppose a ship bound to Calcutta, and ready for sea, lying in Madras roads. The barometer is falling ; the surf rising fast ; it is blowing a smart gale at N. W. b N. ; and signal is made to "cut or slip and stand to sea, as a gale is coming on."

Now place the storm card so that the place of the N. W. b N. wind on any of the circles, (we take the outer one because the wind is not yet a strong or severe gale, and the barometer not *very* low) ; and you will see at once that if you run to sea, steering to the E. N. E. or even East, you pass close to the centre, and that, as not unlikely, if you have the centre bearing even more Easterly from you than it thus appears to do, (because the winds are always irregular when approaching the shore,) you may get into it. If, however, you steer away to the S. E., you will as you may see, gradually bring the wind more Westerly, and in a short run it will come to the Southward of West, when you may haul up gradually as the wind veers till you are upon your true course,\* having thus *sailed round* the heel of the storm, and made a friendly fair wind of a hurricane which might have torn your ship to pieces.†

Again, suppose yourself in about latitude 20° N., longitude 115° East, with the wind varying between West and N. W., a falling barometer and other signs of bad weather, being in the typhoon months withal, and bound to Canton.

Place the storm card on the chart, and it will shew you, that in all human probability, this is a typhoon coming up from the E. S. Eastward or down from the N. Eastward, and that if you stand on upon your direct course, though you may indeed make 50 or 60 miles of latitude, you will be in the very track and heart of it ; but that by

\* And it seems nearly certain, that all the rotatory storms of the Bay of Bengal and China Seas, are followed by a S. E. wind *on their N. Eastern quadrants*.

† See for a capital instance of this management the log of the ship *Lady Clifford*, Captain Miller, lying at Nagore in October 1842, in the Eighth Memoir on the Law of Storms, Jour. As. Soc. Vol. XI.

steering away as before to the S. Eastward, and hauling up gradually as the wind and your barometer\* guide, you will have allowed the storm to pass you, and have only made a little curve, as in the case of a head-wind. The case which I have supposed here, *really happened* between the 27th and 28th September 1809, when a fleet of four of the H. C. China ships, by standing on 64 miles to the Northward, ran headlong into a tremendous tyfoon, in which the *True Briton*, a new ship, foundered, and the other three were not far from it! See Sixth Memoir, "Storms of the China Seas," Jour. As. Soc. Vol. XI.

A word on the *sizes* of our Indian hurricanes may not be misplaced here, as assisting the mariner to form his judgment. Colonel Reid and Mr. Redfield speak of those of the Atlantic Ocean as dilating to 600 and even 1000 miles in diameter; the largest size which I have been able to assign to ours is about 600 miles, and then the evidence for its extent was not very good. The usual size of the vortices in the Bay of Bengal is from 300 to 350 miles, but as before said,—and of this we have a very remarkable and distinct proof in the Coringa hurricane of November 1839, Journal Asiatic Society, No. 100, for 1840—they sometimes contract from that to about 150 miles; augmenting, however, in violence when they do so.

Some of the smaller sized hurricanes in the Bay also seem to move at a rapid rate, and are excessively violent, resembling the tornados on shore, which in tropical climates, and in Bengal especially, destroy literally every thing in their progress, though their tracks are but a few hundred or a thousand yards in breadth. The hurricanes of the China Sea also seem rarely to exceed from two to four degrees, or from 100 to 250 miles in diameter.

Presuming that the seaman now fully understands how he may generally avoid a hurricane, how he may judge of its track, and how he may often make a fair wind of it; it will be necessary next to consider the cases in which, if from want of sea-room, from his position with respect to the centre, or other motives, it may be proper for him to lie to, *what is the proper tack for him to lie to on*. We owe to Colonel Reid also this invaluable deduction from the facts on which

\* In most instances good barometers rise with such regularity after the storm passes the meridian of the ship or station, that they mark its passage with the regularity of a clock! A simple barometer of course more sensibly.

the Law of Storms is based, and every year and every new investigation proves the utility and the beauty of the rule. I cannot do better here for my reader than to extract nearly what he has said p. 425 of 1st edition, and 530 of the second, of his work.

*'Rules for laying Ships to, in Hurricanes.'*—That tack on which a ship should be laid to in a hurricane has hitherto been a problem to be solved; and is one which seamen have long considered important to have explained.

'In these tempests, when a vessel is lying to and the wind veers by the ship's head, she is in danger of getting stern-way\*' even when no sail is set; for in a hurricane, the wind's force upon the ship's masts and yards alone will produce this effect, should the wind veer ahead, and it is supposed that vessels have often foundered from this cause.

'When the wind veers aft as it is called, or by the stern, this danger is avoided, and a ship then comes up to the wind instead of having to break off from it.'

'If great storms obey fixed laws, and the explanation given of them in this work be the true one, then the rule for laying a ship to follows like the corollary to a problem already solved. In order to define the two sides of a storm, that side will be called the right hand semicircle, which is on the right of the ship's course, as we look in the direction in which it is moving, just as we speak of the right bank of a river. The rule for laying a ship to will be, when in the right hand semicircle, to heave to on the starboard tack, and when in the left-hand semicircle, on the larboard tack in both hemispheres.'

The Diagram No. II, is copied from Colonel Reid's book as well as most of the paragraph which follows. It represents one of the West India hurricanes which, being in Northern latitudes, will do for those

\* *From getting stern-way.*—This taking aback in a tempest we all know to be most dangerous, not only on account of the getting stern-way, here mentioned, being pooped, dismasted, and the like; but from another danger, which is not sufficiently adverted to I think; and this is, that a vessel, may, in one of the terrific gusts which accompany these sudden shifts of wind, be thrown on her broadside in the trough of the sea, with her deck *towards* the sea! In such a case she is in the position of a vessel which has fallen over to seaward on a reef; and there is every chance that her hatches would be beaten in, which might swamp her. Hatches are not usually made strong enough.—H. P.

in the Bay of Bengal or China Seas. This storm is supposed to be moving from the S. E. b S. to the N. W. b N. in the direction of the great arrow drawn across it. The commander of a ship can ascertain what part of a circular storm he is falling into by observing how the wind begins to veer. Thus in the figure the ship which falls into the right hand semicircle, would receive the wind at first about E. b N., but it would soon veer to East as the storm passed onward and supposing her lying to. The ship which falls into the left hand half of the storm would receive the wind at first at N. E., but with this latter ship instead of veering towards East, it would veer towards North.

It will be seen now, with reference to what has been said above, that in this figure all the black ships are on the proper tacks, and the white ships are on the wrong ones.

The question of scudding and heaving to, even with sea-room, will depend, as my reader has seen in the explanation of the uses of the storm cards, not only upon the quarter of the storm in which he finds himself, but also on the tracks of the storms. From the researches of Col. Reid, Mr. Redfield, Professor Dove, and others, it is considered as a theoretical law, that the revolving storms within the tropics have always their tracks tending to the West, (viz. as we have shewn for the Bay of Bengal and China Seas travelling *from* the Eastward,) and that they will as they approach high latitudes, curve back towards the Eastward again. This law must of course be modified by many circumstances, such as the vicinity and direction of coasts, the prevalence and direction of monsoons, and the like. Thus we have no instance of storms recurring back *to* the Eastward in the Bay of Bengal, China Sea, or as far North as our data extend ; but in the *Golconda's* hurricane in the China Seas (See Fourth Memoir, Jour. As. Soc. Vol. X,) we have a storm travelling from S.  $10^{\circ}$  E. to N.  $10^{\circ}$  W., while another at the same time was travelling from about E. b S. to the W. b N. The first of these two, from its travelling so near the meridian, is the nearest approach to anything like an attempt at recurring back, but at present the whole amount of our knowledge goes to shew, that this does not take place in the China Sea.

As it is not, however, impossible that Northwards along the Coast of China, as far as the promontory of Shantung and the Gulph of

Pechee-lee the storms *may* curve to the Northward,\* I have given Colonel Reid's plate, which illustrates this recurvature of the storms of the Western hemisphere in North latitudes, and those of the Eastern hemisphere in Southern latitudes, namely, about the Isle of France. In studying it, the seaman will observe that for the high latitudes on the Coast of China, the third circle, which I have marked A, is probably as much curving as he will meet with; and that from the S. E. or South to the N. W. and N. are then the most likely tracks for the storms, though they *may* still come from the N. E. and East as on the South Coast; but by careful attention to his barometer, and the use of his hurricane card, he can always, as I have shewn, obtain by projection a pretty correct notion of the track of the storm. Here is what Colonel Reid has said with reference to this.

It is a point which has been often discussed whether a ship should scud, or not, in a hurricane.

"In a revolving storm there will be one quadrant in which it will be more dangerous for a ship to scud than in the other three; that being the one in which a vessel driven by the wind would be led in advance of the centre of the storm's track; whilst to scud in the opposite quadrant, would tend to lead a ship out of the hurricane. The annexed Diagram, (Plate II. of the present pamphlet,) in which the quadrants of greatest danger are shaded, will serve to explain for both hemispheres what is now meant. Within the tropics, whilst the course of storms tends towards the West, the quadrants of greatest danger will be on the sides of the storm next the poles, but these quadrants will gradually change their position as the storms recurve; and in high latitudes, after the courses of storms become Easterly, these quadrants will be on the sides next the equator.

"The four East India Company's ships which foundered in the *Culloden's* storm were, from the accounts scudding in the most dangerous quadrant of the storm when last seen."

\* Those of the Bay of Bengal, however, do not seem to do so. Coming even from S. E. or nearly so, they strike on the great ranges of the Eastern Ghauts 3 to 4000 feet high, force their way over them, and are either lost and broken up amongst the inner ranges, or re-form as storms in the Arabian Sea. See Eighth Memoir, Journal Asiatic Society, Vol. XII.

For the Arabian Sea, as I have before said, we have almost no knowledge of the tracks of storms, though the day may not be distant when it must be the great high road between India and England. The only storm traced there, in my Eighth Memoir, appeared to be one which after crossing the Bay of Bengal from the Andamans to Madras, forced its way across the Peninsula of India, and thence giving rise to at least two other storms, was finally broken up on the South Coast of Arabia, not far from Aden.

We have now to consider what is known of the approach of these tempests in the Indian and China Seas.·

There is so little known with any degree of certainty of the approach of these storms, that the only safe rule may at once be said to be a close attention to the barometer and simpiesometer, which no ship should be without ; for the man who goes to sea without them, wantonly risks, not only the property of his employers and the lives of his crew, but moreover his own reputation, which must always suffer in some degree by loss and damage ; if it be only to the extent of being thought an ‘ unlucky commander.’

Off the Sand Heads, the signs of a hurricane seem to be mostly light airs from N. E. to S. E. with very hazy or clear hot weather, often with a *very deep* blue sky for a day or two preceding the storm, a heavy swell, close sultry weather, and a strong set to the Westward on the reefs, and this both when the storm has passed to the Southward, and also where it passes directly over the Sand Heads.

We do not know whether this is the case on the southern half of the circle, but I am inclined to think, that it is not so, and that fresh Westerly breezes, with at least hazy, if not dark gloomy weather, will be experienced. In all cases, however, there is a regular fall of the barometer when at distances of 150 and 200 miles from the centre of the storms, so that in truth the barometer well looked after, is by far the safest sign. Mr. Redfield says : “ The barometer sinks under the first half of the storm in every part of its track, except perhaps in extreme northern margin, and thus affords the earliest and nearest indication of the approaching tempest. The barometer again rises during the passage of the last portion of the gale.”

In the China Sea I am inclined to think that in the tyfoons of the

S. W. monsoon, the appearances are much like those of the Bay of Bengal, according to the position of a ship upon the Northern or Southern semi-circle of the tempest. During the N. E. monsoon, the tyfoons seem mostly preceded by a remarkable haze and thin, rapid scud. It appears also, that in some of the tyfoons at this last mentioned season, the barometer gives little or no warning, at least to vessels on the Eastern or Luconia shore of the China sea, but in the case in which this occurred, there was no simpiesometer on board of the vessel, and I think, had there been one, it would at least have "oscillated."

This "*oscillation*" of the simpiesometer, which in one case in the China seas was observed for *twenty-four hours* before a typhoon, and has frequently been so for some time, is a very valuable, and as far as I know, a new indication afforded by this beautiful instrument, perhaps indeed in all cases when it is in good order.\* The barometer also sometimes oscillates at the approach of a storm, but of course its variations are not so extensive, and easily escape notice. One of the signs of its falling I have at times noticed to be, that *it did not rise* at the usual hours of the daily barometric tides. Horsburgh's account of the various appearances which may, and may not, be considered as fore-runners of these storms, is in the hand of every seaman.

Other phœnomena are, a remarkable kind of lightning shooting up something like an aurora borealis, with a dull glare for a short interval, and either at one or various points, or all round the horizon. The wind also sometimes rises and falls with a moaning noise, like that heard in old houses in Europe on winter nights, and this in situations both near and far from the land, and independent of the noise made in the rigging,† and on shore at least, most particularly on the approach

\* This is important. I have little doubt that the oil in the common simpiesometers is affected by light, and becomes viscid when exposed to it. Messrs. Troughton and Sims, at my suggestion, have manufactured a "Tropical Tempest Simpiesometer," of which the two principal improvements are, a door to keep the light from the oil, except when observing, and a tube of such a length, that it will allow of the great depression which sometimes occurs, with a temperature of 75 or 80°, in tropical hurricanes, without any risk of the gas escaping. See Journal Asiatic Society, Vol. XII.

† This very curious phœnomenon *certainly* occurs as I have described it, and is no doubt connected with the "roaring" and "screaming" of the wind in a typhoon. Those who have passed through one, well know that even in a totally dismasted ship, the noise of the wind is fairly entitled to be described by these words.

of a storm, and not when the wind is varying in strength in fine weather.

I have before spoken of the "*storm waves*" and "*storm currents*," as elements of danger or safety in these storms, according as the Mariner may be situated or manage. They are at all events elements which he should carefully take into account when estimating his position at these times. The following is from the conclusion to my Eighth Memoir, Journal Asiatic Society, Vol. XII, and will I hope fully explain what is meant by these terms. It relates to the storm on the Coromandel Coast of October 1842, but the principles are the same everywhere, and the Mariner will find no difficulty in applying them.

"I must not omit also to point out an important practical lesson for the navigator on the Coromandel Coast, which should not be omitted, and it is this: Those who have studied this subject, and are acquainted with the publications of Reid and Redfield relative to the storms of the Western hemisphere, and with my own relative to those of the Eastern hemisphere, are well aware of the abundant evidence which exists, (and there is much more yet unpublished,) to prove the existence of '*storm waves*' and '*storm currents*.'

"To those, however, who are not fully acquainted with the subject, I may say, that the "*storm wave*" is a mass of water of greater or less diameter according to the storm, raised above the usual level of the ocean by the diminished atmospheric pressure and perhaps other causes, and driven bodily along with the storm or before it, and when it reaches bays or river mouths, or other confined situations, causing by its further rise when contracting, dreadful inundations; but upon open coasts rarely so, or not in so great a degree, as it can there spread out quickly and find its level.\* The "*storm currents*" may be briefly described as circular streams on the circumferences of rotatory storms, and of these also we have evidence enough for the mariner at all times to admit, and be on his guard against the *possibility of*, or even the *great probability of*, them.

"We have thus in every storm two sets of forces (currents) independent of that of the wind, acting upon a ship; the one carrying her bodily onward on the track of the storm, and the other drifting her round the periphery of that part of the storm circle in which she may be.

\* The deep sea wave also, (the *flot de fond* of the French writers) no doubt assists the inundation; but as this is not a surface cause, I do not allude to it.

" Taking, as the simplest case, and one nearly that of Madras Roads, a storm travelling from East to West, and striking upon a Coast running North and South, its centre passing over Pondicherry, we should have then, for all ships in the offing, one current, 'the storm wave' carrying them directly on shore, with greater or less velocity, as they were nearer or farther from the centre; and other currents, 'the storm currents' varying in their direction according to the situation of each ship in the storm circle, but always agreeing pretty nearly with the direction of the wind.

" The current of the storm *wave* then is setting due West, but that of the storm *current* West on the North side of the storm circle, and due *East* at its South side; South at its Western edge, and North at its Eastern side, and so on in all the intermediate directions; and a ship putting to sea from Madras roads in our supposed case, will be carried right towards the shore by the *storm wave*, and to the S. Westward also by the *storm current*; but if putting to sea from any place to the Southward of Pondicherry, she would be carried one way by the storm wave, and the opposite one, or partly so, say to the S. E., East, or N. E., by the storm current; so that as to mere Westing, the effect of the one would probably neutralise that of the other. The case of ships on the Northern half of the storm, where both forces are against him, should however be borne seriously in mind by the seaman. It was probably the cause of the indraught which wrecked the ships which were lost in this storm, and of some of the others finding themselves in much shoaler water than from their run, they might reasonably have supposed. Captain Biden's suggestion in the port orders, to keep a due attention to the lead in these cases is then founded not only on merely sound nautical experience, but upon good scientific grounds also. To neglect the lead is a positive act of barratry or folly, for in these storms it is impossible to estimate the true distance from the coast by any other means, and the three forces, the ' storm wave,' ' storm current,' and the drift occasioned by the wind, would form a complex problem in fine weather. The seaman will not fail to recollect how much influence the storm wave may have upon his position in places where, as in the British Channel,\* a storm coming from the Westward, brings with it a vast mass of water from a great Ocean like the Atlantic, so that with a Southerly or South-westerly gale, he finds himself set far

\* I allude here, it will be perceived, to the two recent and harrowing catastrophes of the *Reliance* and *Conqueror*. In both these cases the gale being Westerly, the vessels were on the Southern half of the storm circle, and had thus both the storm wave and storm current carrying them far to the Eastward of their reckoning.

to the Eastward by some hitherto unknown but fatal current: and I trust that when I say that, if we can obtain documents, we may trace out accurately the laws of these dangerous complications, I shall add another claim to the assistance of every right-minded seaman, and of every friend to humanity."

I may add here, that Col. Reid mentions the case of a ship which found that the effect of one West India hurricane was wholly to neutralise the Gulf stream! I have certainly ascertained that the storms at the Sand Heads are preceded and accompanied by a heavy set from the Eastward, which sweeps over them at from 3 to 5 knots an hour; and in the China Sea there is abundant evidence to prove that in the great tyfoons from the E. N. E. coming in from the Northern Pacific, and sweeping the South Coasts of China with an Easterly hurricane, as well as in those of which the tracks cross the middle of the sea, storm currents of extraordinary strength, varying from 50 to 100 miles or more in the 24 hours, are experienced.

I stated in the introductory note, that one of the objects of this little work was to urge upon the public attention the great necessity which exists for farther information and investigation of the TRACKS OF STORMS. These investigations, while I have health, and can by any possibility command time, I shall be most happy to carry on; but I cannot do so without being furnished with the data. If my readers have carefully perused the foregoing pages, they will see that, except for the Bay of Bengal and China Seas, we have yet, as it were, every thing to learn respecting the tracks of storms in all the other seas from the Cape to China, and in the Northern Pacific, or over one-third of the circumference of the globe! and a single experiment with a storm card will shew them, that if a hurricane moved, (for instance across the Bay of Bengal,) from West to East, instead of the contrary way, which we now *know* they do, all the changes of winds and rules for management would be different. Hence the great utility, tedious and sometimes almost repulsive as the labour is, of collecting the data and investigating every separate storm till, as in all other branches of the physical sciences, we are able to say with comparative or absolute certainty, what is the LAW by which their tracks are governed, since we know that of their rotations.

As I have before said, for these investigations we must have data,

and these data are log books, journals, memoranda, newspaper notices, and the like, and the more clearly to explain what we require, I set down here in separate paragraphs, what occurs to me ; premising always, that *the more details, the better.*

1. We require all the accounts, registers, and notices, logs, journals, memoranda, and even *references* to books, (in any language,\*) which can be obtained.

2. These may be new or old, for the phœnomena of the storm of yesterday may be corroborated by those of a hurricane a hundred years ago.

3. They may be plain common-sense notes or narratives, or as scientific as they can be made ; but the plain common-sense accounts are often *quite as valuable* as the scientific descriptions, and it is a great mistake, and one I fear, which has deprived us of much good material, to suppose that we *must* have scientific data, because the research requires the aid of science to develope the laws to which they lead.

4. A mere note of the times of commencement, violence of the wind, from what quarter, how changing, how ending, and the position of the observer on shore, or the latitude and longitudes at sea, with the run, &c. are all that are required. If the barometer, thermometer, simpiesometer, &c. are added, so much the better.

5. The place of the observer at noon each day should be carefully given at sea, even from mere estimation, if nothing better can be obtained ; because no one can, from a log, estimate a vessel's drift in heavy weather so well as those on board of her.

6. On shore, the latitude and longitude of the place, or its distance and bearing from the nearest station should be given ; and some notions of its position, as to mountains, hills, rivers, vallies, &c. will be always useful.

7. Mariners may very usefully employ their own leisure hours, or the leisure hours of any boy on board who can write, during a passage, by copying from their *old* log books, no matter *how* old, the logs of any old storms, or the logs which shew a ship to have been *near* the place of any known storm ; and especially to copy the log of any storm

\* Many valuable hints are to be found in the old navigators, English as well as foreign, but few or none of their works are obtainable in India.

they may have had on the actual voyage, so that it may be ready to send on their arrival in port. I have reason to believe, that many Commanders are willing, and even desirous of aiding us, but when they come into port, they are hurried and anxious, do not like to send their log book out of the ship, and finally leave without carrying their good intentions into effect. Much valuable information is thus lost. As to the old logs, *I have* a great deal of scattered information thus collected, which might become far more valuable, with the addition of a few more corroborations.

8. Another very mistaken notion is, that some are apt to fancy that their particular log, or note, or memorandum on shore is "*of no great consequence.*" This is a very mischievous notion, and I entreat those who may entertain it to consider first, that it is impossible to say before-hand, in any research of this kind, *what* is and what is not important; and next, that twenty proofs are always better than ten.

9. Some also, I fear, who may not have looked into the details, excuse themselves by saying, they do not believe in the truth of the Law of Storms. There is no harm in this opinion—if it does not cost the dismasting or loss of a ship—and I am old enough to have heard Lunars and Chronometers sneered at, as "*new-fangled notions;*" but I think I do not exaggerate when I say, that in the writings already published on the subject, there is to be found, for every impartial mind, abundant and almost mathematical proof of its correctness. And if these researches are not useful, it certainly can do no harm to publish all the facts relative to storms for scientific men to make some other use of.

10. I fear also, that some Shipmasters, who may not have enjoyed a good education in early life, may feel a little embarrassed and unwilling to submit their log books or extracts to the eye of a stranger. I can only assure such, that I have had many log books, in which great deficiencies were observable, but have never, and should on no account think of ridiculing, or even of criticising them.

11. All communications and packets addressed to me at Calcutta, under cover to "*The Secretary to the Government of Bengal, Home Department,*" and marked "*Storm Report Service,*" will reach me free of postage in India.

Persons residing on shore should,

1. Set up a vane or weather-cock if there are none in sight, and if they are not old seamen enough accurately to estimate the point from which the wind blows.

2. They should also, from various parts of the house or bungalow, take North and South and East and West marks *in fine weather*, at not too great a distance, such as trees, chimneys, &c. In a storm they will find these of essential service in estimating the course of the wind, and that of the clouds.

3. If furnished with instruments the registry of all of them before, during, and after a storm, will of course be most acceptable ; but a plain common-sense account of all the phœnomena of a storm ; or of the weather when one is passing near, the driving of the clouds, the *times* of the changes or veerings of the wind, calm interval, &c. &c. are all that is required in most cases, and will always be eminently useful.

4. The collection of reports from other parts is also a most useful assistance to us ; even if native ones, they are better than none.

5. Accounts of tornados or wind-spouts, dust-whirlwinds, &c. their tracks, the direction in which they turn, whether *with*, or *against* the *hands of a watch*, and notes of their formation, progress, ravages and disappearance, are all of great interest and utility.

*In Conclusion.*—Let me intreat those who may have read the foregoing pages to reflect, that this investigation has claims upon every man far above those of most scientific researches. It claims attention alike from the man of science, for it relates to some of the most mysterious and awful phœnomena of our globe—from the merchant, for he is every way interested in its truth—from the seaman, for it is with him a question of life and death, of safety or ruin ; and of disgrace or credit—from the friend of humanity, for it deeply concerns human life and human suffering ; and from all other classes, especially in the colonies, because all are themselves, or by their friends, traversing the pathways of the deep—and finally and emphatically from every Englishman of every class : for if England owes her greatness to any one special cause, it is assuredly to the science, skill and daring which have made her, either in war or peace, the mistress of the ocean and of its shores, and has given to her sovereigns that trident which is “the sceptre

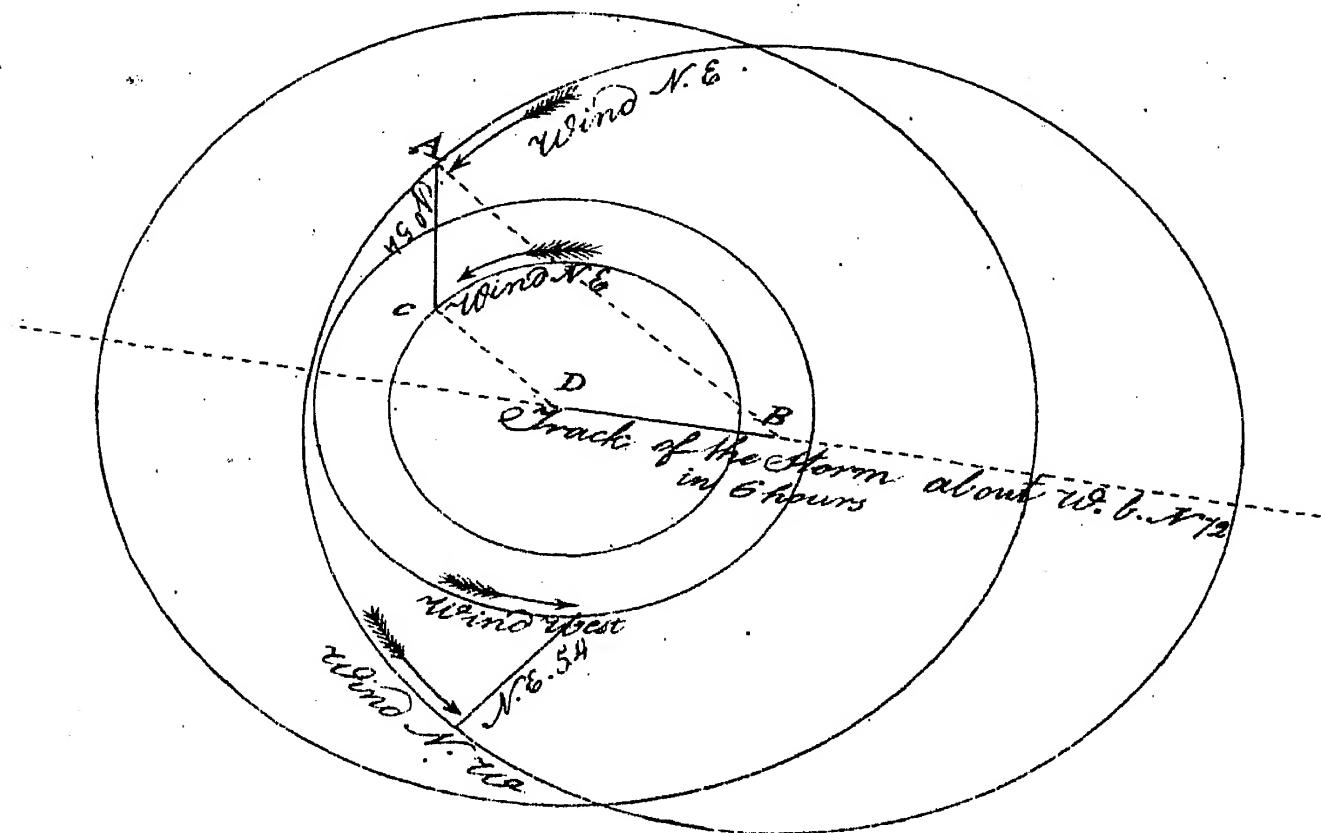
of the world.”\* It is no small advance in that science, no trifling addition to that skill, and no small encouragement to that daring, if through the application of this beautiful science by Colonel Reid’s laws, and the thorough tracing out of all the collateral results to which the researches lead, we can teach the plainest of her ship-masters to guide his bark in comparative safety, and often to use the scourge of the tempest, as a beneficent and a friendly power.

\* Le trident de Neptune est le sceptre du monde!—FRENCH AUTHOR.

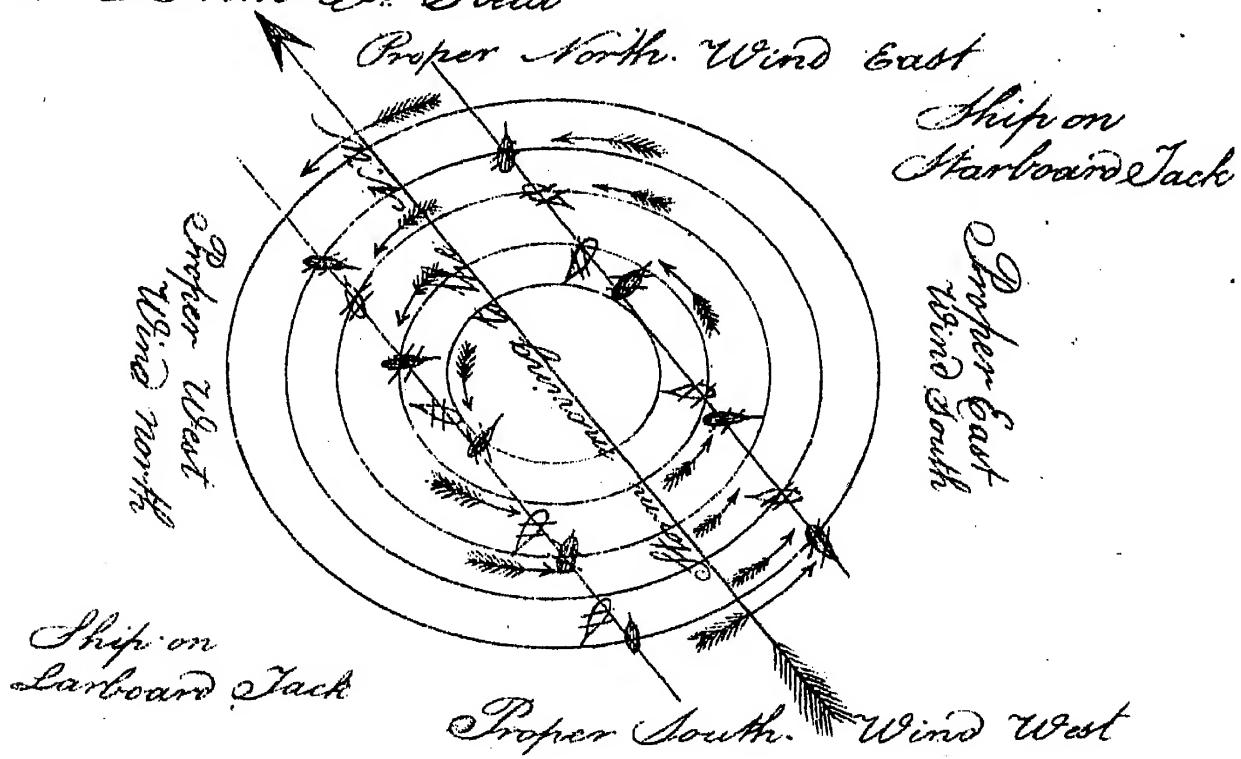
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Diagram No I

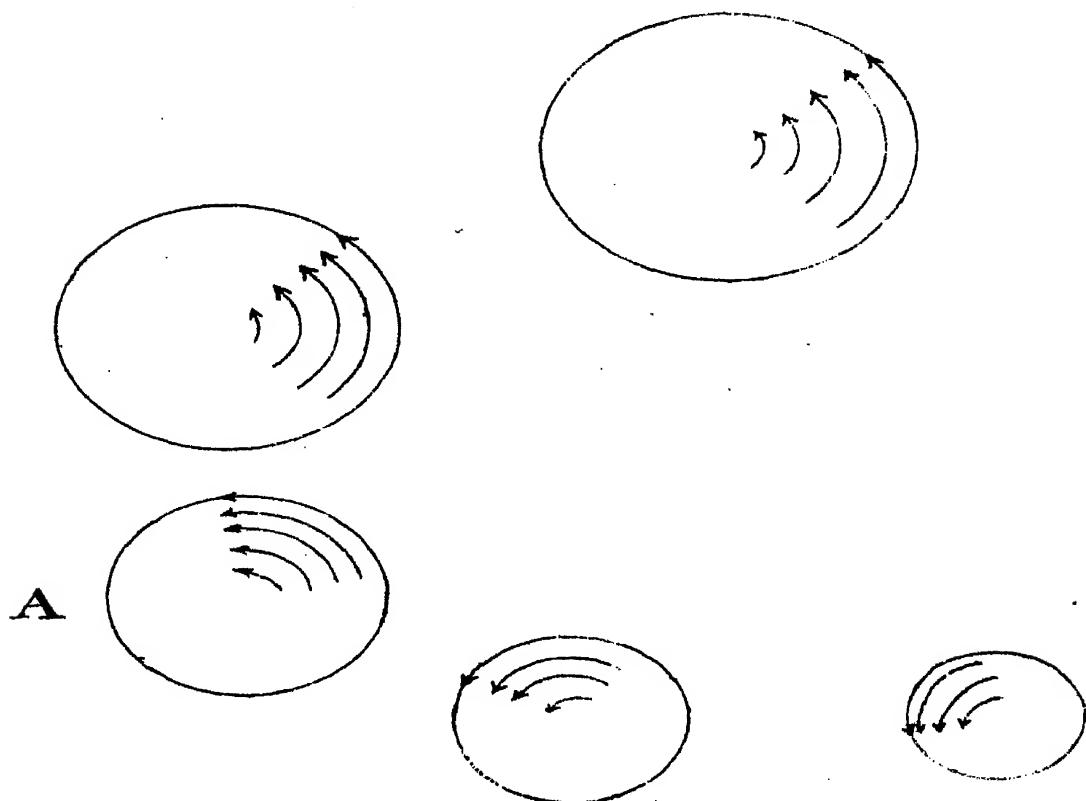
Projection for finding the track of a storm  
Scale 100 miles to an inch.



N<sup>o</sup>. II. From Col. Reid

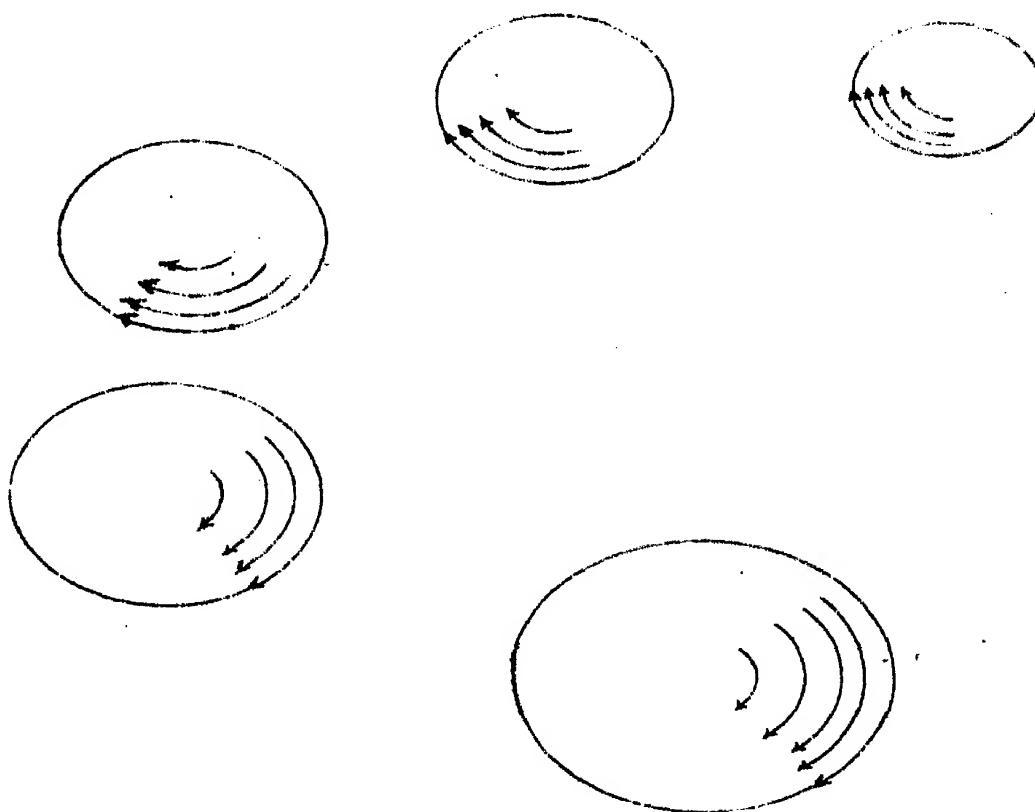


*Diagram III*  
*To Explain the recurving of storms*



*Equator*

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*From Col:Reid's 2<sup>nd</sup> edition*